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The decline and fall of seasonality in the Australian stock exchange, 1958-2005

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Abstract

This paper examines calendar effects in Australian daily stock returns over the forty-seven years from 6 January 1958 to 30 December 2005. Three principal calendar effects – day-of-the-week, day-of-the-month and month-of-the-year – are examined separately and jointly using parametric tests of differences in means and variances and a regression-based approach. The results indicate that the Australian market is characterised by seasonality of all three forms, with Tuesday, December and the second day of the month among the most significant. However, there is also evidence of structural change in these relationships, with indications that the market has become more efficient in recent years, with day-of-the-week and day-of-the-month effects becoming less important in the post-1987 crash period.

JEL classification: C12; C22; G14
Keywords: calendar effects; market anomalies; market efficiency

1. Introduction

A consistent theme in the market efficiency literature has concerned the presence of calendar anomalies or seasonality in stock market returns. If, and as hypothesised, readily identifiable seasonal patterns occur, there is the possibility of abnormal returns through market timing strategies. Within this burgeoning and widely-spread literature, well-known calendar anomalies concerning security returns, include: a weekend effect, where stocks exhibit lower returns between Friday and Monday closing (Agrawal and Ikenberry 1994; Wang and Erickson 1997 Zainudin and Coutts 1997); a day-of-the-week effect, where returns on some trading days are higher than others (Chang et al. 1993; Kamara 1997; Chang et al. 1998); a January effect, where returns are much higher than any other month (Haugen and Jorion 1996; Tonchev and Kim 2004; Rosenberg 2004); a holiday effect, where returns are higher on trading days prior to public holidays (Kim and Park 1994; Chan et al. 1996; Brockman and Michayluk 1998; Vergin and McGinnis 1999; Chong et al. 2005; McGuiness 2005); and a turn-of-the month effect, where returns are higher on the last trading day (Cadsby and Ratner 1992; Tonchev and Kim 2004).

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A number of hypotheses have been put forward to explain the presence of such seasonality, especially concerning its three principal forms: (i) the day-of-the-week effect, (ii) the day-of-the-month effect, and (iii) the month-of-the-year effect. First, the day-of-the-week effect is potentially explained by an *information release hypothesis*, whereby firms delay the release of negative information until late in the week, a *settlement regime hypothesis*, associated with differences in the timing of transactions and settlement, and an *information processing hypothesis* linked with the asymmetry in information costs across small and large investors [see, for example, Keim and Stambaugh (1984), Junkus (1986), Thaler (1987), Rystrom and Bensen (1989), Abraham and Ikenberry (1994), Arsad and Coutts (1997) and Keef and Roush (2005)]. The most commonly reported anomaly in this respect is significantly lower (if not negative) Monday returns. Interestingly, this effect is not consistent in all contexts, with Jaffe and Westerfield (1985), Finn et al. (1991), Easton and Faff (1994), Agrawal and Tandon (1994) and Davidson and Faff (1999) finding a significantly negative Tuesday effect in Australian stock returns, with Jaffe and Westerfield (1985) proposing a linkage between Tuesdays in the Asia-Pacific and the (negative) Monday effect in the US.

Second, the day-of-the-month effect is most often thought of as a turn-of-the-month effect where returns are substantially positive during the first day or two in each trading month [see, for instance, Jacons and Levi (1988), Lalonishok and Smidt (1988), Khaksari and Bubnys (1992), Mills et al. (2000) and Holden et al. (2005)]. Three explanations have been put forward: a *portfolio rebalancing hypothesis*, where investors reinvest accumulated dividends at the end of each month; a *month-end cash flow hypothesis* linked with the transfer of income from salaries and other income into long-term financial assets; and a *company announcement hypothesis* reflecting the preference of companies to delay bad news until late in the reporting period. Finally, the month-of-the-year effect is almost always construed in terms of higher January returns [see, for example, Gultekin and Gultekin (1987), Ariel (1987), Arsad and Coutts (1997), Mehdian and Perry (2002) and Al-Saad and Moosa (2005)]. Once again, three possible explanations have been put forward. These include: the t*ax-loss selling hypothesis* whereby losses on portfolios are fixed for tax purposes at the end of the (US) financial year; a *yearly investor cash flow hypothesis*, where individual investors (and the market) benefit from year-end bonuses, holiday pay and gifts; and a *company announcement hypothesis* whereby January is characterised by an abnormally large release of (positive) firm information.

The purpose of this paper is to add to this intriguing body of work an analysis of calendar effects in the Australian equity market. Although the Australian market has been partially addressed in a number of studies a comprehensive analysis remains, as yet, undone. In particular, it is rare to see a variety of calendar effects analysed in a single study, and as a result their relative strength is unknown. At the same time, it is generally assumed that calendar effects are stable over time, and not subject to the usual changes in market efficiency associated with the development and internationalisation found in contemporary equity markets.

The remainder of the paper is organised as follows. Section 2 explains the empirical methodology and data employed in the study and provides a brief descriptive analysis. The empirical findings are presented and analysed in Section 3. The paper ends with a brief conclusion in the final section.

2. Data and methodology

The data employed in the study are closing prices from the Australian Stock Exchange over the period 6 January 1958 to 30 December 2005 encompassing 12,067 trading days. The capitalization-weighted All Ordinaries Price Index is used. Currently, the index includes the top ASX-listed stocks by capitalization, covering about 92 percent of domestic companies by market value. To be included in the index stocks must have an aggregate market value of at least 0.02 percent of all domestic equities, and maintain an average turnover in excess of 0.5 percent of quoted shares each month. The long-term market index series is obtained from Global Financial Data (2006). A series of daily market returns are calculated where $R_t = 100\ln(P_t/P_{t-1})$ where P_t is the index level at the end of day t. The daily market index and returns for the sample period are presented in Figure 1.

<FIGURE 1 HERE>

Two approaches are used to test the seasonality hypotheses. The first involves a descriptive analysis of the mean returns and tests of equality of means using parametric analysis. The second is a regression-based approach. First, the day-of-the-week effect is examined on the basis of a trading time hypothesis whereby returns are created only on trading days during the week. As an alternative, Mills et al. (2000) proposed a calendar time hypothesis whereby returns are also created on non-trading days: that is, the Monday return would be expected to be some three times larger than returns on other days if the market efficiency null hypothesis holds. The following model is specified:

$$R_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i W_{it} + \varepsilon_t \qquad (1)$$

where W_i is a dummy variable taking a value of one for day i and zero otherwise (where i = 1,2…5) (the reference category is Wednesday), α are parameters to be estimated, ε is the error term and all other variables are as previously defined. The hypothesis tested is $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5$ against the alternative that not all α are equal. If the null hypothesis is rejected, then the stock returns exhibit day-of-the-week seasonality. Second, the day-of-the-month effect is described by the following:

$$R_t = \beta_0 + \sum_{j=1}^{31} \beta_j D_{jt} + \phi_t \qquad (2)$$

where D_j is a dummy variable taking a value of one for day j and zero otherwise (where j = 1,2…31) (the reference category is the twenty-second day of the month), β are parameters to be estimated, ϕ is the error term and all other variables are as previously defined. The hypothesis tested is $H_0 : \beta_1 = \beta_2 ... \beta_{31}$ against the alternative that not all β are equal. If the null hypothesis is rejected, then the stock returns exhibit day-of-the-month seasonality. Third, the month-of-the-year effect is specified as:

$$R_t = \chi_0 + \sum_{k=1}^{12} \chi_k M_{kt} + \varphi_t \qquad (3)$$

where M_k is a dummy variable taking a value of one for month k and zero otherwise (where k = 1,2…12) (the reference category is July), χ are parameters to be estimated, φ is the error term and all other variables are as previously defined. The hypothesis tested is $H_0 : \chi_1 = \chi_2 ... \chi_{12}$ against the alternative that not all χ are equal. If the null hypothesis is rejected, then the stock returns exhibit month-of-the-year seasonality. Finally, a calendar effect model is specified:

$$R_t = \delta_0 + \sum_{i=1}^{5} \alpha_i W_{it} + \sum_{j=1}^{31} \beta_j D_{jt} + \sum_{k=1}^{12} \chi_k M_{kt} + \gamma_t \qquad (4)$$

where all variables and parameters are as previously described, δ is a constant and γ is the error term. If any of the null hypotheses described earlier are rejected, then the stock returns exhibit some form of seasonality. An Augmented Dickey-Fuller test (statistic = -55.4424, *p*-value = 0.0000) and a Phillips-Peron test (with allowance for autocorrelation) (statistic = -

93.1849, *p*-value = 0.0000) reject the null hypothesises of a unit root and we conclude that the return series is stationary and suitable for regression-based analysis.

3. Empirical findings

Table 1 presents the summary of descriptive statistics for the daily returns. These are categorised according to the hypothesised day-of-the-week, day-of-the-month and month-of-the-year effects. In terms of the day-of-the-week, mean returns are highest on Thursday (0.0811) and lowest on Tuesdays (-0.0386). The volatility of returns (as measured by standard deviation) is also highest on Tuesdays (0.9230) and lowest on Fridays (0.7354). For the days-of-the-month, returns are lowest on the twenty-seventh (-0.0855) and highest on the second (0.1824) and most volatile on the twentieth (1.4834) and least volatile on the thirtieth (0.6952). Finally, in terms of calendar months, returns are lowest in September (-0.0402) and highest in December (0.1287) and least variable in July (0.6954) and more variable in October (1.3030).

<TABLE 1 HERE>

By and large, the distributional properties of the returns series in all categories appear non-normal. Given that the sampling distribution of skewness is normal with mean 0 and standard deviation of $\sqrt{6/T}$ where T is the sample size, then returns on Mondays, Tuesdays, Thursdays and Fridays (Wednesdays) are significantly negatively (positively) skewed indicating the greater likelihood of observations lying below (above) the mean. The days-of-the-month are all also significantly skewed, with twenty days being negatively skewed and eleven days being positively skewed. The months are also primarily negatively skewed, with January, July and November being positively skewed. The kurtosis or degree of excess across all return categories is also large, indicating leptokurtic distributions with many extreme observations. Given the sampling distribution of kurtosis is normal with mean 0 and standard deviation of $\sqrt{24/T}$ where T is the sample size, then all estimates are once again statistically significant at any conventional level. Finally, the Jarque-Bera statistics reject the null hypotheses of normality at the .01 level for all returns by category.

3.1 Parametric tests of mean return differences

At first impression, there appears to be strong evidence of calendar effect in the Australian stock market. Consider the days-of-the-week. Tests of the null hypotheses of equal variances are rejected for Monday and Friday (compared to returns on other days). The tests in Table 1 comparing these mean returns also indicate that the differences in means are statistically significant at the .05 level or lower with the exception of Wednesday. With the days-of-the-month, in no instance is the null hypothesis of equal variances rejected and only in the case of the second, sixth, twenty-fourth, twenty-seventh and thirty-first is the null hypothesis of equal means rejected. Finally, return variances are significantly different in February, May, June, July, October, November and December, though significant differences in means at the .10 level or lower are only found in January, February, April, September and December.

3.2 Regression-based analysis of seasonality

The estimated coefficients and standard errors of the parameters detailed in Equations (1) to (4) are presented in Table 2. Equation (1) is detailed in columns 1-3, Equation (2) in columns 4-6, Equation (3) in columns 7-9 and Equation (4) in columns 10-12. Table 3 also includes the R^2 and adjusted R^2, an *F*-test of the null hypothesis that all slope coefficients are jointly zero and Breusch-Godfrey and White's statistics and their *p*-values. Breusch-Godfrey Lagrange multiplier and White's heteroskedasticity tests are used to test for higher-order serial correlation and heteroskedasticity in the least squares residuals, respectively. To start with, the null hypothesis of no serial correlation is rejected for all four models and we may conclude the presence of higher-order serial correlation in the residuals. Then the null hypothesis of no heteroskedasticity in the least squares residuals fails to be rejected for the model based on Equations (1) and (2) and we conclude the presence of heteroskedasticity in the least squares residuals. Accordingly, all standard errors and *p*-values in Table 2 incorporate corrections for heteroskedasticity and autocorrelation following Newey-West.

<TABLE 2 HERE>

Consider the day-of-the-week model. The estimated coefficient for Tuesday is significantly negative while those for Thursday and Friday are significantly positive. Clearly, the Australian market is characterised by the Tuesday effect observed in earlier studies. With the day-of-the-month effect, only the estimated coefficients for the second, twenty-seventh and thirty-first are significant, with the twenty-seventh being negative. With the month-of-the-year model, the coefficients for February and September are both significantly negative. The combined model represented by Equation (4) includes the day-of-the-week, day-of-the-month and month-of-the-year variables with the results being consistent with the earlier findings. In all four models, the null hypothesis of joint insignificance is rejected at the .01 level. The signs on the estimated coefficients in these four models appear to offer support for the posited calendar effects.

In order to evaluate the relative strengths of the competing calendar effects a refined model is obtained employing forward stepwise regression. Twelve variables are stepped in on the basis that the change in the F-statistic is greater than .05 in the following order: Tuesday, December, the second, Monday, January, April, the twenty-seventh, the thirty-first, July, the twentieth, Wednesday and the sixth. The refined model is presented in columns 3-5 of Table 3. Clearly, the negative effect of Tuesday is the most significant calendar effect in the Australian market, followed by the positive effects of December and the second.

<TABLE 3 HERE>

In order to evaluate the stability of this relationship, a Chow breakpoint test (F-statistic = 2.3111, p-value = 0.0046) is conducted with a break on 20 October 1987 (Australia's largest one-day market fall).Since the null hypothesis of parameter stability is rejected, the refined model is re-estimated for two non-overlapping sub-samples: 6 January 1958 to 19 October 1987 and 20 October 1987 to 30 December 2005. The results for these models are presented in columns 6-8 and 9-11, respectively. In general, the significance, magnitude and sign of the coefficients in the earlier period are comparable with the entire sample period. However, in the post-1987 crash period, only the coefficients for December, the second, April and July are still significant. Interestingly, calendar effects in the pre-1987 period and overall are represented by day-of-the-week, day-of-the-month and month-of-the-year effects whereas in the post-1987 period they are represented by month-of-the-year effects and a single day-of-the-month effect.

4. Conclusion

This study examines the presence of calendar effects or seasonality in Australian market returns over the period 1958 to 2005. Three manifestations of calendar effects are examined: namely, the day-of-the-week effect, the day-of-the-month effect and the month-of-the-year effect. Many of the results are consistent with the established literature in Australia and elsewhere: a negative Monday and Tuesday effect, with the latter corresponding to a lagged US market influence; a positive January effect; and a positive market impact on the second of the month corresponding to a turn-of-the-month effect. The three most significant calendar effects over the entire sample period are the negative Tuesday effect, the positive December effect and the positive second of the month effect.

However, the estimated parameters in the equations are not structurally stable over the full sample period and there is a statistically significant intertemporal break at the time of the 1987 stock market crash. The calendar effects are then re-examined in the pre-crash period and post-crash periods. In the pre-crash period, the Australian market is strongly characterised by seasonal factors. But in the post-crash period, the market appears to display less and less complex seasonality. Since seasonal anomalies represent unexploited profit opportunities and violate market efficiency, the disappearance of seasonality may imply that the Australian stock market has gradually become more weak-form efficient in the post-crash period. A number of contributory factors are possible, including the growth in derivative markets, the increasing internationalisation and liberalisation of the domestic capital market, increased trading by institutional rather than individual investors and the dramatic fall in transaction costs, especially those relating to brokerage, taxation and information procurement.

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Figure 1
Daily All Ordinaries index and returns, Monday 6 January 1958 to Friday 30 December 2005

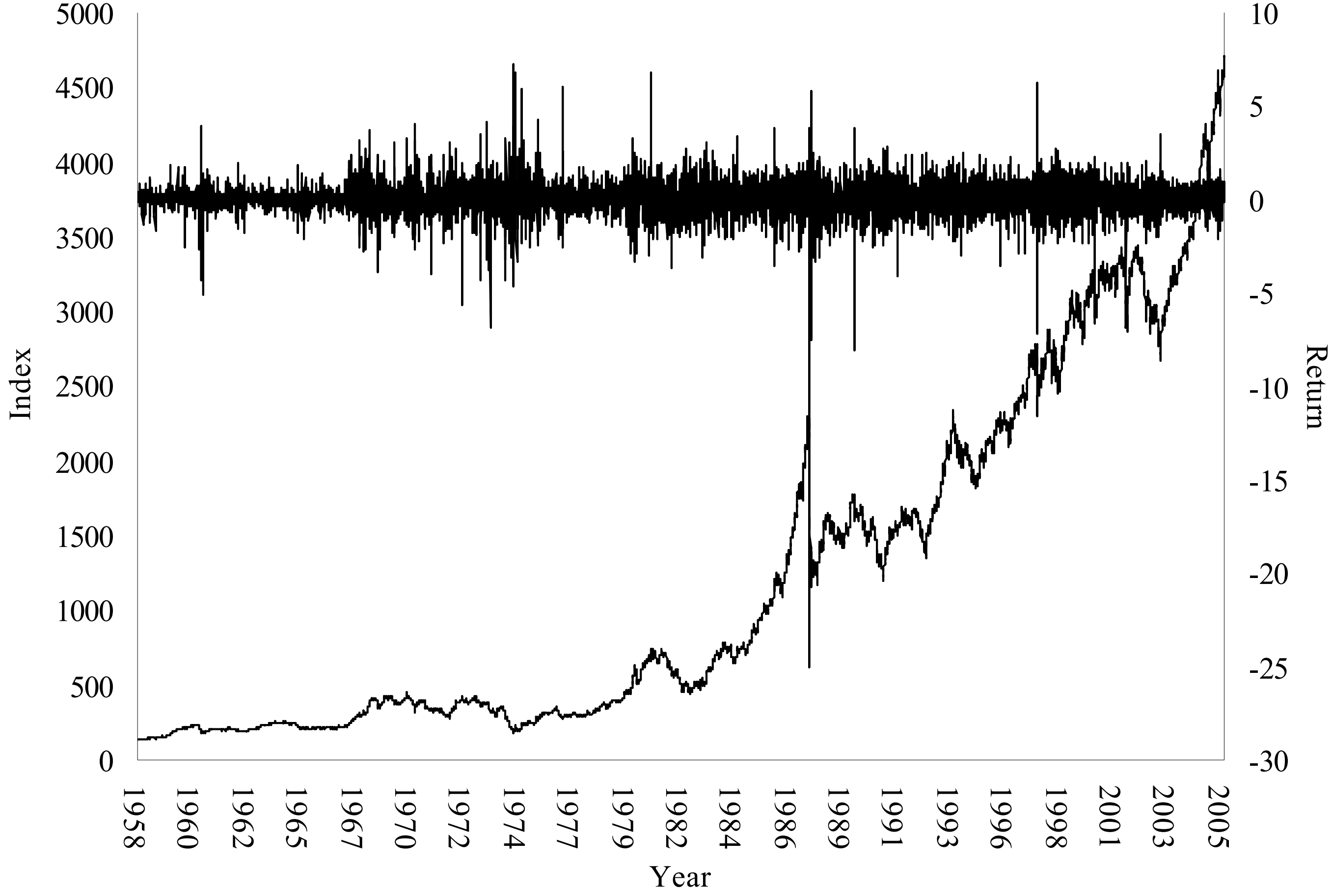

Table 1
Descriptive analysis of daily returns

Variable	Variable category							Reference category			Tests of equality of variances		Tests of equality of means	
	Number	Mean	Standard deviation	Skewness	Kurtosis	JB statistic	JB p-value	Number	Mean	Standard deviation	F-statistic	p-value	t-statistic	p-value
Monday	2258	0.0005	0.9069	-0.5911	14.9106	1.3E+04	0.0000	9810	0.0405	0.8116	20.4010	0.0000	1.9236	0.0545
Tuesday	2458	-0.0386	0.9230	-8.2871	223.7458	5.0E+06	0.0000	9610	0.0513	0.8039	0.2896	0.5905	4.7926	0.0000
Wednesday	2470	0.0398	0.8081	0.4218	10.7877	6.3E+03	0.0000	9598	0.0312	0.8360	0.5772	0.4474	-0.4610	0.6448
Thursday	2467	0.0811	0.7604	-0.3131	9.9222	5.0E+03	0.0000	9601	0.0206	0.8470	2.0094	0.1564	-3.2273	0.0013
Friday	2414	0.0800	0.7354	-0.5551	10.9265	6.4E+03	0.0000	9654	0.0212	0.8521	12.5719	0.0004	-3.4006	0.0007
First	362	0.0828	0.7592	0.1772	6.3177	1.7E+02	0.0000	11706	0.0314	0.8324	0.4701	0.4930	-1.1601	0.2460
Second	393	0.1824	0.7637	1.0230	8.0937	4.9E+02	0.0000	11675	0.0279	0.8321	0.1162	0.7332	-3.6295	0.0003
Third	395	0.0869	0.7776	-0.2954	6.0002	1.5E+02	0.0000	11673	0.0311	0.8320	0.3662	0.5451	-1.3133	0.1891
Fourth	396	0.0050	0.8208	-1.0038	10.8828	1.1E+03	0.0000	11672	0.0339	0.8307	0.0596	0.8071	0.6828	0.4948
Fifth	401	0.0782	0.7280	-0.1357	5.3464	9.3E+01	0.0000	11667	0.0314	0.8336	0.6117	0.4341	-1.1097	0.2672
Sixth	405	0.1137	0.7035	0.1688	5.7757	1.3E+02	0.0000	11663	0.0302	0.8343	2.3059	0.1289	-1.9906	0.0465
Seventh	402	0.0347	0.7762	-0.1520	4.5050	3.9E+01	0.0000	11666	0.0329	0.8322	0.1477	0.7008	-0.0427	0.9659
Eighth	404	0.0006	0.7327	0.4331	5.3945	1.1E+02	0.0000	11664	0.0341	0.8335	0.1541	0.6947	0.7961	0.4260
Ninth	404	-0.0251	0.7141	-0.0865	4.2772	2.8E+01	0.0000	11664	0.0350	0.8340	0.4048	0.5246	1.4311	0.1524
Tenth	404	-0.0175	0.8206	-1.4335	16.6805	3.3E+03	0.0000	11664	0.0347	0.8307	0.0031	0.9556	1.2425	0.2141
Eleventh	403	0.1055	0.9266	0.6588	13.1067	1.7E+03	0.0000	11665	0.0305	0.8267	3.7654	0.0523	-1.6035	0.1096
Twelfth	398	0.0499	0.7794	-0.0337	9.2562	6.5E+02	0.0000	11670	0.0324	0.8320	0.1482	0.7003	-0.4124	0.6800
Thirteenth	401	-0.0205	0.7185	1.2938	13.3939	1.9E+03	0.0000	11667	0.0348	0.8339	0.6935	0.4050	1.3126	0.1893
Fourteenth	405	0.0013	0.7841	0.2540	5.1468	8.2E+01	0.0000	11663	0.0341	0.8319	0.0062	0.9374	0.7797	0.4356
Fifteenth	405	0.0335	0.7440	-0.2617	4.4989	4.3E+01	0.0000	11663	0.0330	0.8332	0.3607	0.5481	-0.0127	0.9898
Sixteenth	402	0.0090	0.8179	-2.7232	28.2426	1.1E+04	0.0000	11666	0.0338	0.8308	1.2186	0.2697	0.5886	0.5561
Seventeenth	407	0.0641	0.8499	-0.7902	12.5267	1.6E+03	0.0000	11661	0.0319	0.8297	0.0002	0.9882	-0.7700	0.4413
Eighteenth	408	0.0392	0.8014	-0.1512	5.2205	8.5E+01	0.0000	11660	0.0328	0.8314	1.1095	0.2922	-0.1542	0.8775
Nineteenth	408	0.0270	0.7768	-0.9546	7.9934	4.9E+02	0.0000	11660	0.0332	0.8322	0.5520	0.4575	0.1480	0.8823
Twentieth	404	-0.0546	1.4834	-11.5769	200.2460	6.6E+05	0.0000	11664	0.0360	0.7981	2.3696	0.1237	2.1559	0.0311
Twenty-first	409	-0.0086	0.7106	-0.1737	4.6249	4.7E+01	0.0000	11659	0.0344	0.8342	0.8059	0.3693	1.0314	0.3024
Twenty-second	412	0.0403	0.7162	0.5816	5.3447	1.2E+02	0.0000	11656	0.0327	0.8341	0.3319	0.5646	-0.1825	0.8552
Twenty-third	408	0.0326	0.8378	-1.3708	15.9682	3.0E+03	0.0000	11660	0.0330	0.8301	0.1753	0.1753	0.0082	0.9935
Twenty-fourth	406	-0.0372	0.7199	0.0995	4.9339	6.4E+01	0.0000	11662	0.0354	0.8338	0.8507	0.3564	1.7326	0.0832
Twenty-fifth	340	-0.0127	0.8649	1.5657	18.0331	3.3E+03	0.0000	11728	0.0343	0.8293	0.4829	0.4871	1.0295	0.3033
Twenty-sixth	359	-0.0083	0.9100	-1.8070	14.9946	2.3E+03	0.0000	11709	0.0342	0.8278	1.4210	0.2333	0.9563	0.3389

Variable	Variable category							Reference category			Tests of equality of variances		Tests of equality of means	
	Number	Mean	Standard deviation	Skewness	Kurtosis	JB statistic	JB *p*-value	Number	Mean	Standard deviation	*F*-statistic	*p*-value	*t*-statistic	*p*-value
Twenty-seventh	379	-0.0855	0.8832	-2.2715	15.8758	2.9E+03	0.0000	11689	0.0368	0.8283	0.5544	0.4566	2.8231	0.0048
Twenty-eighth	385	0.0239	0.9468	-0.2913	18.3481	3.8E+03	0.0000	11683	0.0333	0.8263	0.7343	0.3915	0.2181	0.8274
Twenty-ninth	375	0.0859	0.9951	-0.2771	20.7262	4.9E+03	0.0000	11693	0.0313	0.8245	2.4246	0.1195	-1.2534	0.2101
Thirtieth	365	0.0897	0.6952	0.0685	4.2634	2.5E+01	0.0000	11703	0.0312	0.8342	0.6442	0.4222	-1.3253	0.1851
Thirty-first	222	0.1662	0.7456	-0.1467	4.4705	2.1E+01	0.0000	11846	0.0305	0.8317	0.1687	0.6813	-2.4130	0.0158
January	965	0.1015	0.7742	0.5985	7.8368	1.0E+03	0.0000	11103	0.0270	0.8348	0.0390	0.8434	-2.6722	0.0075
February	962	-0.0195	0.8099	-0.3183	4.9638	1.7E+02	0.0000	11106	0.0375	0.8320	3.0314	0.0817	2.0901	0.0368
March	1038	0.0106	0.7529	-0.0438	5.6609	3.1E+02	0.0000	11030	0.0351	0.8373	0.2948	0.5872	0.9086	0.3636
April	915	0.1002	0.7666	-0.4023	8.9872	1.4E+03	0.0000	11153	0.0275	0.8351	0.3237	0.5694	-2.5494	0.0108
May	1062	0.0348	0.7188	-0.0302	5.3423	2.4E+02	0.0000	11006	0.0328	0.8403	3.1802	0.0746	-0.0871	0.9306
June	982	0.0076	0.7171	-0.4423	10.1574	2.1E+03	0.0000	11086	0.0352	0.8396	7.6777	0.0056	1.1388	0.2550
July	1063	0.0657	0.6954	0.0717	5.4641	2.7E+02	0.0000	11005	0.0298	0.8422	6.7212	0.0095	-1.5755	0.1154
August	1040	0.0256	0.7346	-0.3418	6.4766	5.4E+02	0.0000	11028	0.0337	0.8388	2.3241	0.1274	0.3014	0.7631
September	1029	-0.0402	0.8305	-0.5825	16.4350	7.8E+03	0.0000	11039	0.0398	0.8300	0.0014	0.9703	2.9584	0.0031
October	1040	-0.0055	1.3030	-7.4288	138.3602	8.0E+05	0.0000	11028	0.0366	0.7709	49.0219	0.0000	1.0262	0.3050
November	1027	0.0007	0.9328	0.5708	13.6128	4.9E+03	0.0000	11041	0.0360	0.8201	6.8415	0.0089	1.1690	0.2427
December	944	0.1287	0.7005	-0.0390	5.3304	2.1E+02	0.0000	11124	0.0248	0.8400	6.3817	0.0115	-4.3012	0.0000

Notes: Sample period is Monday 6 January 1958 to Friday 30 December 2005. The reference category is all observations other than the variable category i.e. for Monday returns the reference category is Tuesday, Wednesday, Thursday and Friday returns, for the First, the reference category is returns for all other days-of-the month; for January the reference category is all other months-of-the-year; number – number of observations in each category; Levene's test for equality of variances determines whether the *t*-statistics and *p*-values for equality of means assume equal or unequal variances;

Table 2
Estimated coefficients and standard errors of day-of-the-week, day-of-the-month, month-of-the-year and calendar effect models

	Day-of-the-week effect			Day-of-the-month effect			Month-of-the-year effect			Calendar effect		
	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value
Constant	0.0398	0.0164	0.0149	0.0403	0.0353	0.2533	0.0657	0.0291	0.0238	0.0762	0.0504	0.1303
Monday	-0.0393	0.0252	0.1191	–	–	–	–	–	–	-0.0361	0.0253	0.1536
Tuesday	-0.0784	0.0243	0.0012	–	–	–	–	–	–	-0.0782	0.0243	0.0013
Wednesday	–	–	–	–	–	–	–	–	–	–	–	–
Thursday	0.0412	0.0209	0.0484	–	–	–	–	–	–	0.0413	0.0209	0.0486
Friday	0.0402	0.0223	0.0719	–	–	–	–	–	–	0.0410	0.0223	0.0662
First	–	–	–	0.0425	0.0536	0.4276	–	–	–	0.0486	0.0538	0.3659
Second	–	–	–	0.1421	0.0510	0.0053	–	–	–	0.1437	0.0508	0.0047
Third	–	–	–	0.0466	0.0527	0.3765	–	–	–	0.0479	0.0523	0.3604
Fourth	–	–	–	-0.0354	0.0553	0.5227	–	–	–	-0.0340	0.0552	0.5381
Fifth	–	–	–	0.0379	0.0514	0.4612	–	–	–	0.0382	0.0514	0.4567
Sixth	–	–	–	0.0734	0.0490	0.1340	–	–	–	0.0731	0.0490	0.1357
Seventh	–	–	–	-0.0056	0.0522	0.9146	–	–	–	-0.0060	0.0520	0.9083
Eighth	–	–	–	-0.0397	0.0508	0.4352	–	–	–	-0.0395	0.0508	0.4371
Ninth	–	–	–	-0.0655	0.0495	0.1863	–	–	–	-0.0642	0.0494	0.1933
Tenth	–	–	–	-0.0578	0.0536	0.2805	–	–	–	-0.0578	0.0532	0.2775
Eleventh	–	–	–	0.0652	0.0576	0.2576	–	–	–	0.0661	0.0577	0.2518
Twelth	–	–	–	0.0095	0.0529	0.8567	–	–	–	0.0106	0.0528	0.8414
Thirteenth	–	–	–	-0.0609	0.0507	0.2297	–	–	–	-0.0602	0.0505	0.2332
Fourteenth	–	–	–	-0.0390	0.0526	0.4588	–	–	–	-0.0393	0.0525	0.4546
Fifteenth	–	–	–	-0.0068	0.0505	0.8926	–	–	–	-0.0067	0.0504	0.8945
Sixteenth	–	–	–	-0.0313	0.0551	0.5697	–	–	–	-0.0305	0.0549	0.5785
Seventeenth	–	–	–	0.0238	0.0546	0.6629	–	–	–	0.0252	0.0542	0.6420
Eighteenth	–	–	–	-0.0011	0.0518	0.9830	–	–	–	0.0001	0.0512	0.9977
Nineteenth	–	–	–	-0.0133	0.0537	0.8041	–	–	–	-0.0125	0.0534	0.8145
Twentieth	–	–	–	-0.0949	0.0878	0.2800	–	–	–	-0.0934	0.0874	0.2851
Twenty-first	–	–	–	-0.0490	0.0464	0.2909	–	–	–	-0.0482	0.0460	0.2944
Twenty-second	–	–	–	–	–	–	–	–	–	–	–	–
Twenty-third	–	–	–	-0.0077	0.0504	0.8791	–	–	–	-0.0069	0.0503	0.8912
Twenty-fourth	–	–	–	-0.0775	0.0506	0.1258	–	–	–	-0.0763	0.0503	0.1298
Twenty-fifth	–	–	–	-0.0530	0.0581	0.3615	–	–	–	-0.0360	0.0577	0.5335
Twenty-sixth	–	–	–	-0.0486	0.0607	0.4234	–	–	–	-0.0370	0.0603	0.5394
Twenty-seventh	–	–	–	-0.1258	0.0604	0.0372	–	–	–	-0.1225	0.0598	0.0406

	Day-of-the-week effect			Day-of-the-month effect			Month-of-the-year effect			Calendar effect		
	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value
Twenty-eighth	–	–	–	-0.0164	0.0599	0.7840	–	–	–	-0.0132	0.0598	0.8247
Twenty-ninth	–	–	–	0.0456	0.0634	0.4726	–	–	–	0.0441	0.0634	0.4866
Thirtieth	–	–	–	0.0494	0.0506	0.3295	–	–	–	0.0462	0.0507	0.3614
Thirty-first	–	–	–	0.1259	0.0605	0.0375	–	–	–	0.1122	0.0600	0.0616
January	–	–	–	–	–	–	0.0358	0.0446	0.4223	0.0381	0.0443	0.3903
February	–	–	–	–	–	–	-0.0852	0.0405	0.0352	-0.0776	0.0404	0.0548
March	–	–	–	–	–	–	-0.0551	0.0399	0.1672	-0.0549	0.0400	0.1698
April	–	–	–	–	–	–	0.0345	0.0431	0.4229	0.0371	0.0431	0.3891
May	–	–	–	–	–	–	-0.0309	0.0419	0.4614	-0.0307	0.0419	0.4644
June	–	–	–	–	–	–	-0.0581	0.0382	0.1280	-0.0563	0.0381	0.1399
July	–	–	–	–	–	–	–	–	–	–	–	–
August	–	–	–	–	–	–	-0.0402	0.0378	0.2879	-0.0397	0.0376	0.2911
September	–	–	–	–	–	–	-0.1060	0.0412	0.0102	-0.1023	0.0411	0.0128
October	–	–	–	–	–	–	-0.0713	0.0589	0.2267	-0.0705	0.0587	0.2294
November	–	–	–	–	–	–	-0.0650	0.0419	0.1210	-0.0610	0.0419	0.1455
December	–	–	–	–	–	–	0.0630	0.0410	0.1246	0.0583	0.0411	0.1566
R^2	0.0031	–	–	0.0049	–	–	0.0037	–	–	0.0114	–	–
Adjusted R^2	0.0028	–	–	0.0024	–	–	0.0028	–	–	0.0077	–	–
F-statistic	9.5052	–	0.0000	1.9638	–	0.0013	4.0258	–	0.0000	3.0844	–	0.0000
Breusch-Godfrey	183.5907	–	0.0000	180.6823	–	0.0000	178.6054	–	0.0000	172.8116	–	0.0000
White	1.3061	–	0.2651	1.0380	–	0.4088	3.1858	–	0.0002	1.5799	–	0.0080

Dependent variable is daily returns on All Ordinaries index. Sample period Monday 6 January 1958 to Friday 30 December 2005. The dummy variable reference categories are Wednesday, twenty-second and July. F-test of null hypothesis that all slope coefficients are zero. Breusch-Godfrey – Breusch-Godfrey serial correlation LM test for ordinary least squares regression model, White – White heteroskedasticity test for ordinary least squares regression model. All standard errors and *p*-values incorporate Newey-West corrections for heteroskedasticity and autocorrelation of unknown form.

Table 3
Estimated coefficients and standard errors of refined calendar effect model

Sample	Stepping statistics		Monday 6 January 1958 to Friday 30 December 2005			Monday 6 January 1958 to Monday 19 October 1987			Tuesday 20 October 1987 to Friday 30 December 2005		
	Δ F-statistic	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value	Coefficient	Std. error	*p*-value
Constant	–	–	0.0462	0.0134	0.0006	0.0773	0.0168	0.0000	-0.0075	0.0224	0.7372
Tuesday	22.9693	0.0000	-0.1194	0.0216	0.0000	-0.1857	0.0228	0.0000	0.0158	0.0318	0.6206
December	13.4079	0.0003	0.1217	0.0311	0.0001	0.1298	0.0406	0.0014	0.1030	0.0466	0.0272
Second	13.1330	0.0003	0.1530	0.0393	0.0001	0.1331	0.0449	0.0030	0.1846	0.0720	0.0104
Monday	10.9130	0.0010	-0.0781	0.0203	0.0001	-0.1155	0.0242	0.0000	-0.0171	0.0358	0.6336
January	9.0643	0.0026	0.0970	0.0352	0.0059	0.1275	0.0491	0.0094	0.0369	0.0407	0.3651
April	9.9292	0.0016	0.1003	0.0337	0.0029	0.0977	0.0440	0.0264	0.0969	0.0497	0.0511
Twenty-seventh	7.1266	0.0076	-0.1128	0.0447	0.0117	-0.1154	0.0545	0.0342	-0.1092	0.0788	0.1656
Thirty-first	5.6789	0.0172	0.1296	0.0495	0.0089	0.1286	0.0548	0.0190	0.1325	0.0928	0.1536
July	5.2459	0.0220	0.0617	0.0309	0.0461	0.0501	0.0406	0.2171	0.0737	0.0437	0.0920
Twentieth	4.2965	0.0382	-0.0837	0.0730	0.2513	-0.0252	0.0539	0.6396	-0.0174	0.0620	0.7791
Wednesday	4.0695	0.0437	-0.0412	0.0195	0.0347	-0.0844	0.0235	0.0003	0.0297	0.0338	0.3803
Sixth	3.8909	0.0486	0.0826	0.0351	0.0186	0.1383	0.0410	0.0007	-0.0079	0.0627	0.8998
R^2	–	–	0.0091	–	–	0.0163	–	–	0.0051	–	–
Adjusted R^2	–	–	0.0081	–	–	0.0148	–	–	0.0025	–	–
F-statistic	–	–	9.1752	–	0.0000	10.3167	–	0.0000	1.9548	–	0.0243

Dependent variable is daily returns on All Ordinaries index. Coefficients are obtained from stepwise regression of calendar effect model in Table 2 over the Monday 6 January 1958 to Friday 30 December 2005, stepping criteria Δ F-statistic *p*-value > .05. Varying sample periods detailed in uppermost row of table. *F*-test of null hypothesis that all slope coefficients are zero. All standard errors and *p*-values incorporate Newey-West corrections for heteroskedasticity and autocorrelation of unknown form.